



**NOTE:**  
EITHER A 74LS245 OR AN AM8304B MAY BE  
USED AT LOCATION E3. PIN NUMBERS NOT  
ENCLOSED IN PARENTHESIS ARE FOR 74LS245.  
PIN NUMBERS IN PARENTHESIS ARE FOR AN  
AM8304B.

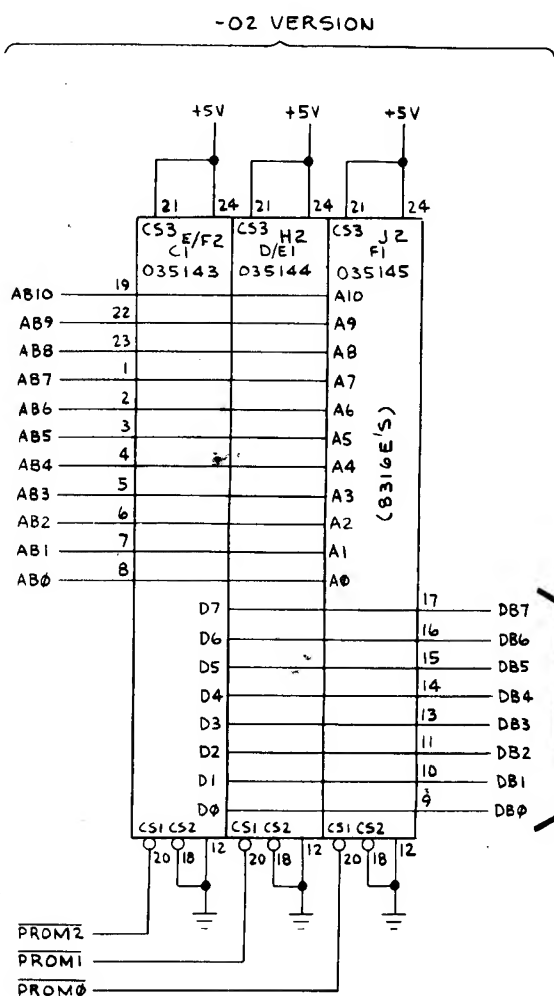
3E00  
4000-47FF  
5000-57FF  
6800-7FFF

Asteroids game is con-  
version of the PCB or  
the PCB. One ROM is  
II PROMs connected to  
removed before replac-  
ble, remove PROMs at  
before replacing with

## RAM CIR

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MPU) is  
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R/WB is  
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RAM. Th  
ibility.



### NOTE:

All reference designations in red are for the -05 and -06 PCB assemblies only. For example, the 8316E ROM above is at location F1 on the -01 thru -04 PCB, but is at location J2 on a -05 and -06 PCB.

The reference designations, used in the circuit descriptions, refer to the -01 thru -04 PCB assemblies only.

-03 P.C. Boards (PROMs)	Alternate -03 P.C. Boards (PROMs)
035131-02 J2	035150-02 J2
035132-02 N2	
035137-02 K1	035153-02 K1
035138-02 N1	
035133-02 H2	035151-02 H2
035134-02 M2	
035139-02 J1	035154-02 J1
035140-02 M1	
035135-02 F2	035152-02 F2
035136-02 L2	
035141-02 H1	035155-02 L1
035142-02 L1	

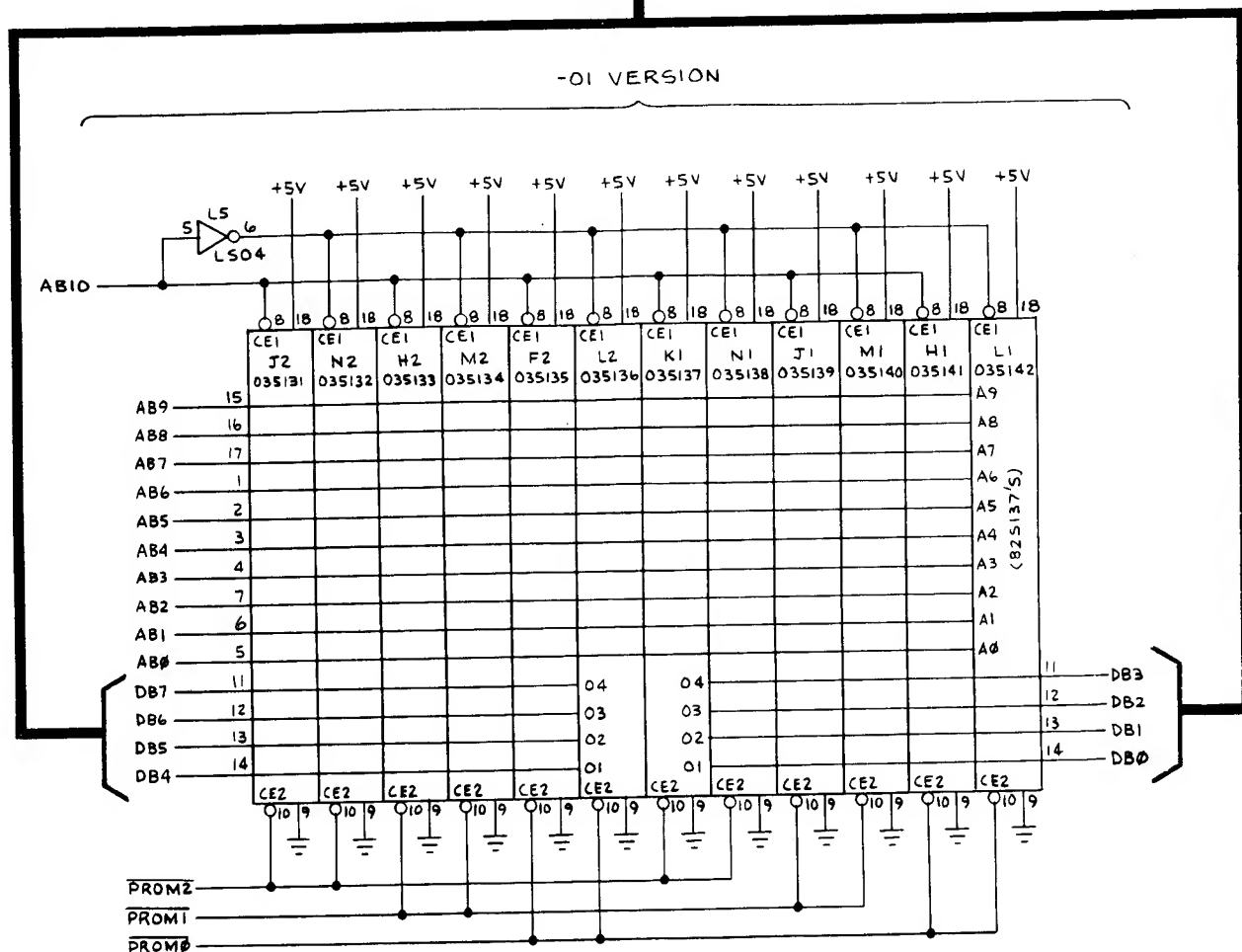
The NMI (non-maskable interrupt) counter causes an interrupt at the NMI input of the MPU every 4 msec. The interrupt is derived by dividing 3 KHz by a factor of 12 through counter C5. The interrupt occurs when pin 6 of inverter B5 goes low. During power-up, the NMI counter is disabled by RESET. During Self-Test, the NMI is disabled by TEST.

1 2 3 4 5 6

FROM SWITCH INPUTS  
SHEET 2, SIDE B

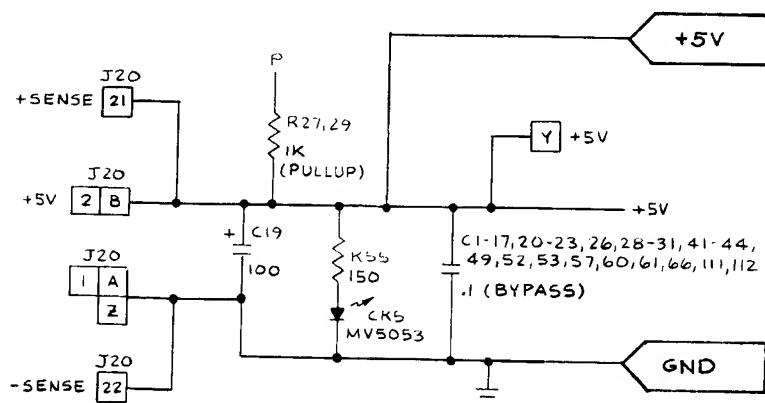
## ROM/PROM CIRCUITRY

Program Memory for the Asteroid  
tained in PROMs for the -01 version  
ROMs for the -02 version of the PC  
equivalent to four PROMs. All PROM  
a common enable must be removed  
ing with a ROM. For example, rem  
locations F2, H1, L2 and L1 before  
ROM at location F1.



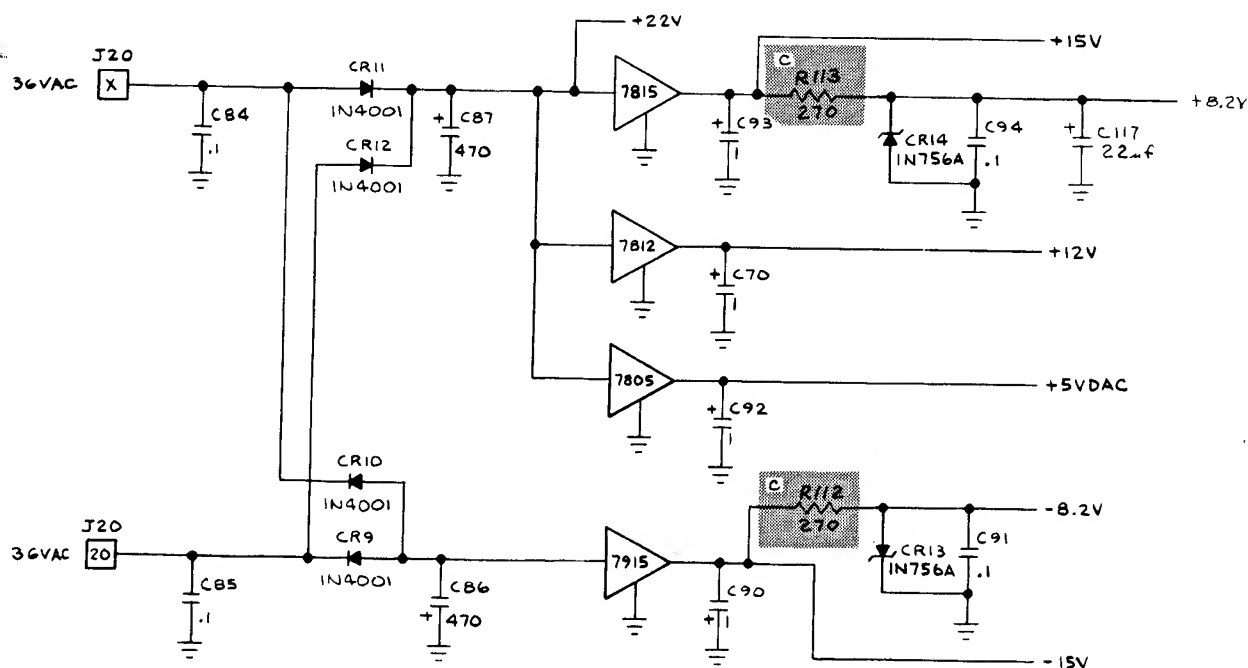


## POWER INPUT

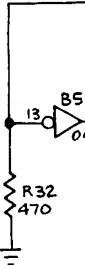


This circuitry consists of the PCB inputs and outputs for the +5 VDC logic power and 36 VAC input to the on board regulators. The +5 VDC inputs and outputs are discussed on Sheet 1, Side A of this schematic set.

The 36 VAC inputs are received by two full wave rectifiers. Diodes CR9 and CR10 rectify the negative cycle of the input and the 7915 regulates the voltage at  $-15$  VDC. Diodes CR11 and CR12 rectify the positive pulse of the 36 VAC input and the 7815 regulates the voltage at  $+15$  VDC. The 7812 regulates at  $+12$  VDC. The 7805 regulates an additional 5 VDC for the DACs. Zener diode CR14 supplies the  $+8.2$  VDC for the sample and hold circuit. The  $+22$ V (unregulated) is used to power operational amplifiers P11 and L8 in the audio output.

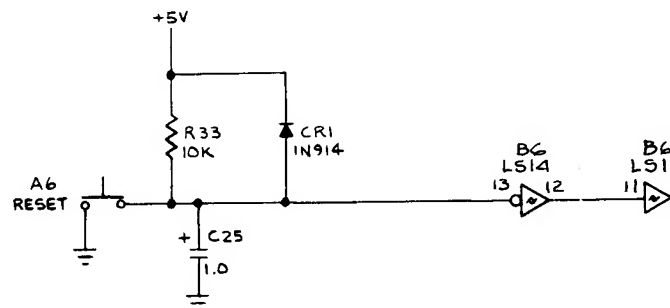


## CLOCK CIRCUIT



The clock circuit consists of inverters and counters C4 and B4 which divide the crystal frequency down to the Asteroids game.

## POWER RESET AND

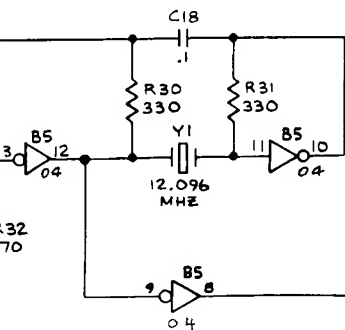


During initial power-up, the delayed charging of capacitor C25 causes a preset of flip-flop D4 and a clear of counter D5. This results in holding RESET input to the MPU low. When the charge of C25 reaches about 1.5 VDC, preset and clear inputs are removed. Counter D5 counts to 128 at 3 KHz rate and RESET is removed (goes high) from the input of the MPU. This allows the logic power input to the PCB to stabilize before allowing the MPU to begin its initialization routine.

If the MPU program is operating properly, the MPU address decoding circuitry will output the WDCLR (Watchdog clear) signal at predetermined intervals. This serves to clear counter D5 before it counts up to the state that will create the RESET condition. If the MPU program strays from its intended sequence and does not output the WDCLR signal, counter D5 will count up to the RESET state and cause the MPU to return to its initialization routine.



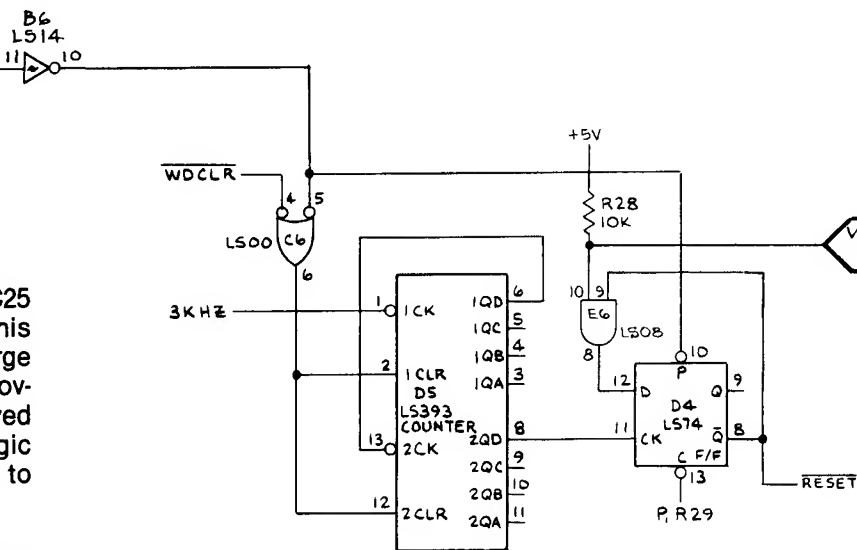
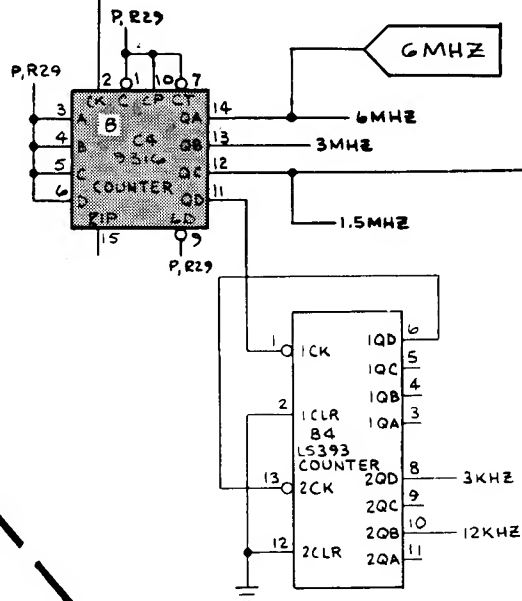
denotes change by indicated revision



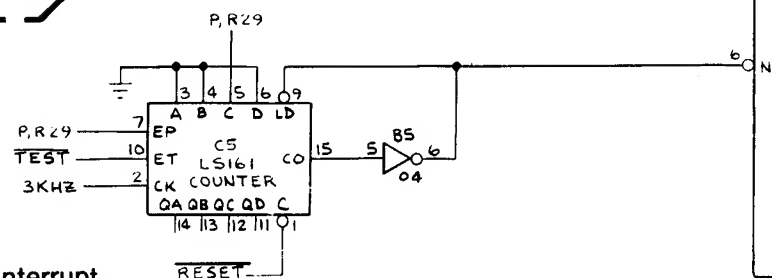
**NOTE:**  
THE MPU IN THIS GAME OPERATES AT A FREQUENCY OF 1.5 MHZ. THEREFORE THE MPU CHIP MUST BE 6502A. THE 6502'S MAXIMUM FREQUENCY IS 1 MHZ AND IS NOT COMPATIBLE WITH THIS GAME.

ists of crystal Y1 and associated in-  
nd B4. Counters C4 and B4 count the  
the frequencies necessary for the

## AND WATCHDOG COUNTER



## NMI COUNTER

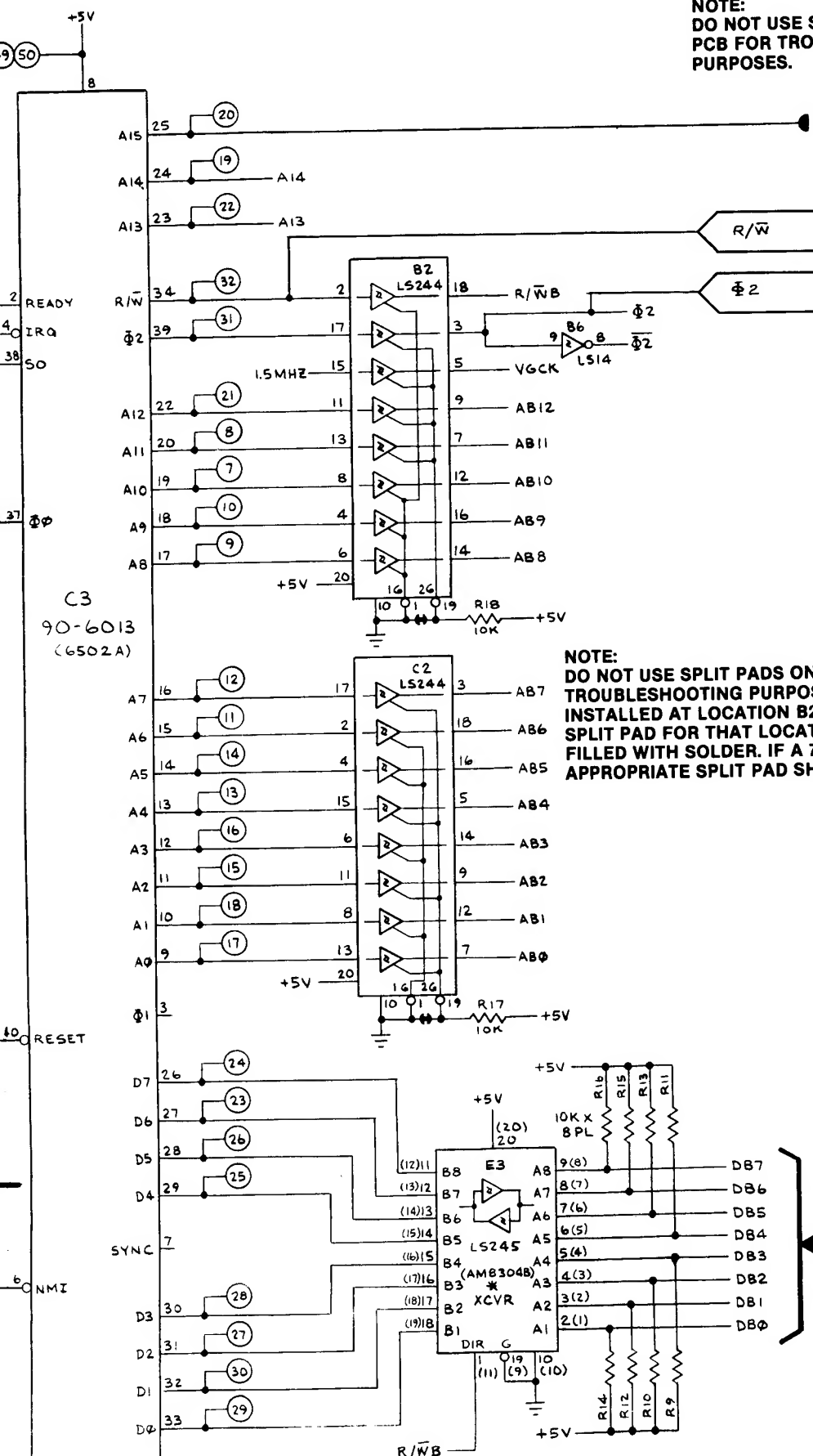


The NMI (non-maskable interrupt) counter causes an interrupt at the NMI input of the MPU every 4 msec. The interrupt is derived by dividing 3 KHz by a factor of 12 through counter C5. The interrupt occurs when pin 6 of inverter B5 goes low. During power-up,

# MPU CIRCUITRY

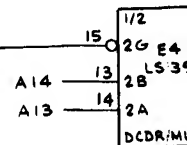
# ADDRESS D

NOTE:  
DO NOT USE SPLIT PADS ON  
PCB FOR TROUBLESHOOTING  
PURPOSES.



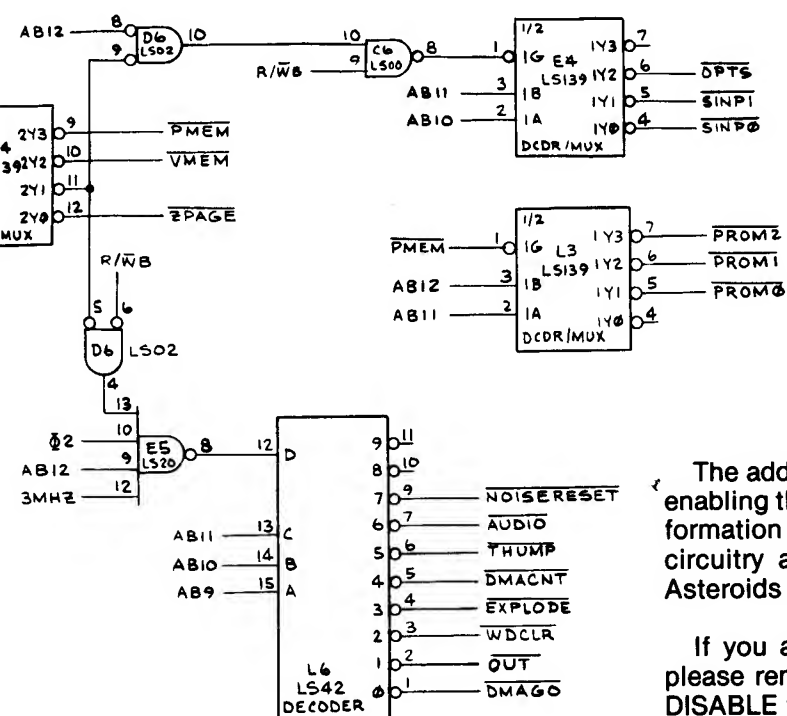
NOTE:  
DO NOT USE SPLIT PADS ON PCB FOR  
TROUBLESHOOTING PURPOSES. IF A 74LS244 IS  
INSTALLED AT LOCATION B2 AND/OR C2, THE  
SPLIT PAD FOR THAT LOCATION SHOULD BE  
FILLED WITH SOLDER. IF A 74LS241 IS USED, THE  
APPROPRIATE SPLIT PAD SHOULD BE OPEN.

NOTE:  
EITHER A 74LS245 OR AN AM8304B MAY BE  
USED AT LOCATION E3. PIN NUMBERS NOT



HEXADECIMAL	A15
0000-01FF	
0200-02FF	
0300-03FF	
2001	
2002	
2003	
2004	
2005	
2006	
2007	
2400	
2401	
2402	
2403	
2404	
2405	
2406	
2407	
2800	
2801	
2802	
2803	
3000	
3200	
3200	
3200	
3200	
3200	
3400	
3600	
3600	
3A00	
3A00	
3C00	
3C01	
3C02	
3C03	
3C04	
3C05	
3E00	
4000-47FF	
5000-57FF	
6000-7FFF	

## DECODING CIRCUITRY



The address decoder performs the function of turning on or enabling the appropriate circuitry at the critical time, so that information can be transferred back and forth between the game circuitry and the MPU. The memory map below is for the Asteroids game.

If you are going to use the Automatic RAM/ROM Tester, please remember to remove MPU C3 and ground the WDOG DISABLE test point.

ADDRESS															DATA								FUNCTION	
A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	R/W	D7	D6	D5	D4	D3	D2	D1		D0
0	0				0	1	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	ZERO & ONE PAGE RAM PLAYER 1 RAM PLAYER 2 RAM
0	0				1	0	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	
0	0				1	1	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	
0	1	0	0	0								0	0	1	R	D								3 KHz
0	1	0	0	0								0	1	0	R	D								HALT
0	1	0	0	0								0	1	1	R	D								HYPERSPACE SW
0	1	0	0	0								1	0	0	R	D								FIRE SW
0	1	0	0	0								1	0	1	R	D								DIAG. STEP
0	1	0	0	0								1	1	0	R	D								SLAM SW
0	1	0	0	0								1	1	1	R	D								SELF TEST SW
0	1	0	0	1								0	0	0	R	D								LEFT COIN SW
0	1	0	0	1								0	0	1	R	D								CENTER COIN SW
0	1	0	0	1								0	1	0	R	D								RIGHT COIN SW
0	1	0	0	1								0	1	1	R	D								1 PLYR START SW
0	1	0	0	1								1	0	0	R	D								2 PLYR START SW
0	1	0	0	1								1	0	1	R	D								THRUST SW
0	1	0	0	1								1	1	0	R	D								ROT RIGHT SW
0	1	0	0	1								1	1	1	R	D								ROT LEFT SW
0	1	0	1	0								0	0	0	R							D	D	OPT SW (SW8, SW7)
0	1	0	1	0								0	1	0	R							D	D	OPT SW (SW6, SW5)
0	1	0	1	0								1	0	1	R							D	D	OPT SW (SW4, SW3)
0	1	0	1	0								1	1	1	R							D	D	OPT SW (SW2, SW1)
0	1	1	0	0	0	0									W								D	DMAGO
0	1	1	0	0	0	1									W									2 PLYR START LAMP
0	1	1	0	0	1										W						D			1 PLYR START LAMP
0	1	1	0	0	1										W									RAMSEL
0	1	1	0	0	1										W				D					COIN CNTRL LEFT
0	1	1	0	0	1										W			D						COIN CNTRC CENTER
0	1	1	0	0	1										W			D						COIN CNTRR RIGHT
0	0	1	0	1	0										W									WDCLR
0	1	1	0	1	1										W	D	D							EXPLOSION PITCH
0	1	1	0	1	1										W			D		D				EXPLOSION VOLUME
0	1	1	1	1	0										W				D		D			THUMP VOLUME
0	1	1	1	0	0										W				D		D	D		THUMP FREQUENCY
0	1	1	1	1	0							0	0	0	W	D								SAUCER SOUND
0	1	1	1	1	0							0	0	1	W	D								SAUCER FIRE SOUND
0	1	1	1	1	0							0	1	0	W	D								SAUCER SOUND SELECT
0	1	1	1	1	0							0	1	1	W	D								SHIP THRUST SOUND
0	1	1	1	1	0							1	0	0	W	D								SHIP FIRE SOUND
0	1	1	1	1	0							1	0	1	W	D								LIFE SOUND
0	1	1	1	1	1										W									NOISE RESET
1	0	0	0	0	0	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	D	VECTOR RAM VECTOR ROM